

REMARKS / ARGUMENTS

Claims 1, 2, 5-9, 12 and 13 are currently pending in the application and are rejected to. Claims 1 are amended. Claims 2, 5, 7, 12, and 13 are cancelled without prejudice or disclaimer. Claims 14-18 are newly submitted.

This Office Action is in response to **Amendment** filed on October 13, 2005. **Claims 1, 5, 7-8 and 23 were amended, Claims 2-3 and 10-11 were cancelled**, while no new Claims was added. To be more specific, the limitation from dependent **Claims 2-3 or 10-11** were incorporated into parent Claims 1 and 8; parent **Claims 1, 7 and 13** were amended to use the proper language of "consisting of" for terpolymer as pointed out by the Examiner in interview conducted on September 7, 2005; while dependent Claim 5 was only amended to use correct Claim dependency. The title has been changed to "high electrostrictive polymer". **Claims 1-2, 5-9 and 12-13 are now pending** with four independent Claims (Claims 1, 7-8 and 13). The Examiner **accepts Applicant's drawing in three sheets with Figure 1-6** filed on November 21, 2003 with this application. An action follows.

Applicant's argument on October 13, 2005 has been fully considered but they are not persuasive. The focal arguments related to the patentability will be addressed as follows: In view of the Applicants' argument on pages 14-28 of Remarks, all

the 102 and 103 rejections are sustained while new rejection on 112-second paragraph is applied.

Claims 1 and 8 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly Claims the subject matter which Applicants' regard as the invention.

On parent **Claims 1 and 8**, it is very clear that **the narrow down in three different ways for "at least one monomer" is "vague and indefinite"**. In a close examination, **such "at least one monomer" can be any one of the following three choices** as: **(A)** monomer selected from the group consisting of 1-chloro-2-fluoroethylene and 1-chloro-1fluorethylene, **(B)** monomer has **at least one halogen atom** side group, wherein said halogen atom side group is chlorine, **and (C)** monomer favors gauche-type linkage along a backbone of a polymer chain of said terpolymer. The Examiner understands that the Applicants are incorporating limitations from dependent **Claims 2-3 or 10-11** into parent Claims 1 and 8 according to the interview discussion conducted on September 7, 2005. In summary, the Applicants need to rewrite in a clear and definite language according to MPEP rule.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. § 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the Claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or non-obviousness.

The limitation of parent **Claim 1** is present invention relates to an electrostrictive terpolymer consisting of: (A) **vinylidene fluoride**; (B) **trifluoroethylene**; and (C) at least one monomer, wherein said at least one monomer is **an ethylene-based monomer selected from the group consisting of 1-chloro-2-fluoroethylene and 1-chloro-1-fluoroethylene and said at least one monomer has and has at least one halogen atom side group**, wherein said halogen atom side group is chlorine and wherein said at least one monomer favors **gauche-type** linkage along a backbone of a polymer chain of said terpolymer.

Parent **Claim 7** relates to terpolymer of Claim 1 with a specific combination of VDF, TrFE and CFE (chlorofluoroethylene). Parent **Claims 8 and 13** each relates to a method of making film of terpolymer from Claims 1 and 7.

See other limitations of dependent **Claims 2, 5-6, 9 and 12**.

Claims 1-2, 5-9 and 12-13 are rejected under 35 U.S.C. § 102(b) as being anticipated by or, in the alternative, under 35

U.S.C. § 103(a) as obvious over Honn et al (U.S. 3,318,854) for the reasons set forth in **paragraphs 4-5 of office action dated 6-24-2005 as well as the discussion below.**

Claims 1-2, 6, 8-9 and 12 are rejected under 35 U.S.C. § 102(b) as being anticipated by Nakamura et al. (U.S. 4,543,293) for the reasons set forth in **paragraphs 6-7 of office action dated 6-24-2005 as well as the discussion below.**

Claims 5, 7 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakamura et al. (U.S. 4,543,293) in view of Honn et al. (U.S. 3,318,854) for the reasons set forth in **paragraph 9 of office action dated 6-24-2005 as well as the discussion below.**

**Applicants:** Applicant has Claimed an unexpected way of obtaining an electrostrictive terpolymer consisting of: (A) **vinylidene fluoride**; (B) **trifluoroethylene**; and (C) **"at least one monomer"**. With the interview discussion conducted on September 7, 2005, the C component for "at least one monomer" in parent **Claims 1 and 8** has been amended to carry the extra limitations from dependent Claims 3-4 or 10-11. Parent **Claims 1, 7 and 13** were amended to use the proper language of "consisting of" instead of "comprising" for terpolymer. The Applicants have also presented several arguments on pages 16-27 of Remarks with respect to 102 and 103 rejections.

**Examiner:** As discussed in the above-mentioned 112-second paragraph rejection, **such "at least one monomer" in parent Claims 1 and 8 can be any one of following three choices as:**

**(A)** monomer selected from the group consisting of 1-chloro-2-fluoroethylene and 1-chloro-1-fluoroethylene, **(B)** monomer has at least one halogen atom side group, wherein said halogen atom side group is chlorine, **and (C)** monomer favors gauche-type linkage along a backbone of a polymer chain of said terpolymer. In a very close examination by this Examiner, **component C or B is not necessarily to be component A, while component C is also not necessarily to be component (B).**

The Examiner understands that the Applicants are trying to incorporate limitations from dependent **Claims 2-3 or 10-11** into parent Claims 1 and 8 according to the interview discussion conducted on September 7, 2005. The Applicants need to rewrite in a clear and definite language according to MPEP rule.

With respect to amended **Claims 1-2, 5-9 and 12-13**, all directly relate to original Claims 1-13 and have support in the specification and Claims originally filed, they **still carry the same scope of original limitations**. Since the same rationale recited in the rejection of original Claims 1-13 can be applied to reject Claims 1-2, 5-9 and 12-13, all the 102 and 103 rejections are sustained.

In the first instance, the applicant appreciates the courtesies extended during the interview of January 26, 2006. In conjunction with this interview and subsequent interview summary, the following remarks and supporting declaration are submitted. The rejections and objections of this Office Action are respectfully traversed in view of these amendments and remarks that follow:

In the Office Action, claims 1 and 8 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants' regard as the invention. In response, claims 1 and 8 have been amended.

In regard to claim 1, the claim has been amended to recite exact ranges for percentages of the vinylidene fluoride, trifluoroethylene and the ethylene-based monomers. As such, the claim particularly points out and distinctly claims the subject matter which Applicants' regard as the invention. As a result, the rejection of the Office Action is resolved for claim 1.

In regard to claim 8, the claim has been amended to recite exact ranges for percentages of the vinylidene fluoride, trifluoroethylene and the ethylene-based monomers. As such, the claim particularly points out and distinctly claims the subject matter which Applicants' regard as the invention. As a result, the rejection of the Office Action is resolved for claim 8.

In the Office Action, claims 1-2, 5-9 and 12-13 were rejected under 35 U.S.C. § 102(b) as being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Honn et al (U.S. 3,318,854) for the reasons set forth in paragraphs 4-5 of office action dated 6-24-2005 as well as the discussion above. In response, claims 2, 5, 7, 12 and 13 have been cancelled without prejudice or disclaimer; therefore, the rejection of the Office Action is resolved for these claims.

In regard to claims 1 and 8, the claims have been amended to recite exact ranges for percentages of the vinylidene fluoride, trifluoroethylene and the ethylene-based monomers. As such, the claims are further distinguished from the Honn reference in which the cited reference neither teaches nor suggests the composition of the claims of the present invention.

Specifically, the Honn reference is essentially a synthetic reference describing how to make certain types of polymers. The Honn reference does not go into much detail as to why one skilled in the art would want to do this, or what the end use of the polymers are. The goal of the Honn reference was to make "soft", thermoset vulcanizates of fluorinated, linear and saturated elastomers. The disclosure of the reference actually predates the discovery of piezoelectric behavior in fluorinated hydrocarbon polymers such as PVDF and PVDF-TrFE:

High strain electrostriction in the PVDF-TrFE family of polymer is known in the art by discovery at Penn State University. By high strain, this means strains of 4% to 5%. Prior to this discovery, this family of polymers was not known to exhibit high electrostrictive strains. Certain formulations were known to exhibit modest piezoelectric strains (ca. 0.3% to 0.4%). PVDF-TrFE was initially converted to a high-strain electrostrictor via large doses of high-energy beta radiation. The invention describes a way to achieve the same effect solely by chemical synthesis. The "right" polymer can be synthesized from the start and the radiation processing step can be avoided.

The beta radiation treatment of the pre-existing method is slow and expensive (it takes time to build up the required high doses). The treatment also limits the size of the finished pieces (the width of the radiation beam is limited). In addition, the polymer must be processed in a special laboratory - the material cannot be applied and processed in the field or *in situ*. Finally, the radiation damages the polymer in ways that are not desirable - but there is no way to avoid this damage and convert the PVDF-TrFE into a high strain electrostrictor.

The invention, as recited by claims 1 and 8, produces a polymer that is high strain electrostrictor without any additional processing steps. No radiation or stretching is

required. Once the film is cast and electroded, it is ready for use. Thus, the size and shape of the final film are not restricted, the polymer could be applied to a surface in situ or in the field, and the polymer itself is not damaged or compromised in any way (unlike the results of the radiation treatment).

Referring again to the Honn reference, the claims 1 and 8 of the present application would not be "obvious" to one skilled in the art in view of the cited reference. How the beta particles are converted PVDF-TrFE into a high-strain electrostrictor is not understood without undue experimentation. The high energy particles cause a number of chemical and physical changes in the polymer, only a few of which were "beneficial" from the perspective of creating a high-strain electrostrictor. All of these changes have to be identified and examined for their effect on high-strain electrostriction in the polymer, using a variety of state-of-the-art polymer analysis techniques (FTIR, thermal analysis, fluorine-19 NMR, etc.).

Once it is understood how beta radiation changes PVDF-TrFE into a high-strain electrostrictor, the same changes strictly have to be figured out through chemistry. This approach suggests that certain monomers should produce the desired effect. The end result is the modification of PVDF-TrFE from a copolymer to a terpolymer of the form PVDF-TrFE-X, where "X" is

a small amount of a third monomer that makes the resulting terpolymer a high-strain electrostrictor.

Also noteworthy is that the synthetic technique being taught by the Honn reference is that of crosslinking fluorinated, linear, saturated polymers so that the polymers remain elastomeric. The cited reference does not claim to have invented the polymers mentioned; what the reference claims are techniques for crosslinking and vulcanizing the polymers. Crosslinking is not part of the present application.

In the present application, the polymers remain saturated, linear and uncrosslinked. Crosslinked polymers tend to lose their thermoplasticity and solubility - and both of these characteristics are important for the polymers described in the present application. As such, the major purpose of the Honn reference is not relevant to the present application.

The issue previously raised and repeated in this Office Action, namely "at least 10% of the polymers should be  $-CH_2$  units," does not pertain to the present application. The Honn reference states that the reason for this is that the resulting polymers remain elastomeric. The chemistries specified in the present application are necessary to ensure that the resulting polymers exhibit high strain electrostriction. The Honn reference did not invent the polymers in the reference uses known structures which are similar but not identical. The

reason for making these polymers are completely different such that the compositions needed for electrostriction presented by the polymers of the present invention would not be obvious to one skilled in the art in view of the Honn reference.

Restated, claims 1 and 8 have been amended to recite exact ranges for percentages of the vinylidene fluoride, trifluoroethylene and the ethylene-based monomers. As such, the claims are further distinguished as explained in the remarks above from the Honn reference in which the cited reference neither teaches nor suggests the composition of the claim of the present invention. As a result, the rejection of the Office Action for claim 1, 8 and dependant claim 9 is resolved.

In the Office Action, claims 1-2, 6, 8-9 and 12 were rejected under 35 U.S.C. § 102(b) as being anticipated by Nakamura et al. (U.S. 4,543,293) for the reasons set forth in paragraphs 6-7 of office action dated 6-24-2005 as well as the discussion above. In response, claims 2, 6 and 12 have been cancelled without prejudice or disclaimer; therefore, the rejection of the Office Action is resolved for these claims.

In regard to claims 1 and 8, the claims have been amended to recite exact ranges for percentages of the vinylidene fluoride, trifluoroethylene and the ethylene-based monomers. As such, the claims are further distinguished from the Nakamura

reference in which the cited reference neither teaches nor suggests the composition of the claims of the present invention.

Specifically, the Nakamura reference is for a piezoelectric polymer. The polymers covered in the present application are not piezoelectric - they are electrostrictive. High strain, electrostrictive polymers based upon PVDF-TrFE were not discovered until the late 1990's. Thus, the Nakamura reference is not relevant to the present application in that the cited reference is not concerned with high strain electrostrictive fluoropolymers and that such materials would not even be discovered until fifteen years after the issue date of the Nakamura reference.

It is also noted that the polymer discussed in the Nakamura reference is a terpolymer of VDF, TrFE and VF (vinyl fluoride). The terpolymers discussed in the present application are terpolymers of VDF, TrFE and CFE (chlorofluoroethylene). These are two completely different materials. The Nakamura reference discusses replacing VF with tetrafluoroethylene, hexafluoropropylene and chlorotrifluoroethylene, but never discusses the use of CFE.

The Nakamura reference also tries to make a non-brittle, piezoelectric polymer with a high coupling constant. The polymers of the present application are non-brittle but are electrostrictive and exhibit much higher strains and coupling

constants. The polymers of the cited reference, being piezoelectric, need to be heat-treated and poled prior to use. The polymers of the present application, being electrostrictive, do not need such treatments in order to be electrostrictive.

The invention, as recited by claims 1 and 8, produces a polymer that is high strain electrostrictor without any additional processing steps. No radiation or stretching is required. Once the film is cast and electroded, it is ready for use. Thus, the size and shape of the final film are not restricted, the polymer could be applied to a surface in situ or in the field, and the polymer itself is not damaged or compromised in any way (unlike the results of the radiation treatment).

Referring again to the Nakamura reference, the claims 1 and 8 of the present application are neither taught nor suggested by the cited reference. How the beta particles are converted PVDF-TrFE into a high-strain electrostrictor is not understood without undue experimentation. The high energy particles cause a number of chemical and physical changes in the polymer, only a few of which were "beneficial" from the perspective of creating a high-strain electrostrictor. All of these changes have to be identified and examined for their effect on high-strain electrostriction in the polymer, using a variety of state-of-

the-art polymer analysis techniques (FTIR, thermal analysis, fluorine-19 NMR, etc.).

Once it is understood how beta radiation changes PVDF-TrFE into a high-strain electrostrictor, the same changes strictly have to be figured out through chemistry. This approach suggests that certain monomers should produce the desired effect. The end result is the modification of PVDF-TrFE from a copolymer to a terpolymer of the form PVDF-TrFE-X, where "X" is a small amount of a third monomer that makes the resulting terpolymer a high-strain electrostrictor.

Restated, claims 1 and 8 have been amended to recite exact ranges for percentages of the vinylidene fluoride, trifluoroethylene and the ethylene-based monomers. As such, the claims are further distinguished with support from the remarks above from the Nakamura reference in which the cited reference neither teaches nor suggests the composition of the claim of the present invention. As a result, the rejection of the Office Action for claim 1, 8 and dependant claim 9 is resolved.

In the Office Action, claims 5, 7 and 13 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Nakamura et al. (U.S. 4,543,293) in view of Honn et al. (U.S. 3,318,854) for the reasons set forth in paragraph 9 of office action dated 6-24-2005 as well as the discussion above. In response, claims 5 and 13 have been cancelled without prejudice or disclaimer;

7 and 13 have been cancelled without prejudice or disclaimer; therefore, the rejection of the Office Action is resolved for these claims.

Claims 14-18 are new submitted for consideration and supportable without adding new matter to the present application.

In view of the Remarks and the Declaration submitted herewith, the Applicants respectfully request reconsideration and allowance of the application.

The Examiner is invited to telephone Michael P. Stanley, Attorney for Applicants, at 401-832-6393 if, in the opinion of the Examiner, such a telephone call would serve to expedite the prosecution of the subject patent application.

Respectfully submitted,  
THOMAS RAMOTOWSKI ET AL

27 February 2006

A handwritten signature in dark ink, appearing to read "Michael P. Stanley", is written over a horizontal line.

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